

SENSING THE SOIL QUALITY USING IoT

Submitted in partial fulfillment of the requirements for the award of
Master's of Engineering Degree in

Computer Science and Engineering

By

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**INSTITUTE OF SCIENCE AND TECHNOLOGY
(Deemed to be University)**

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BONAFIDE CERTIFICATE

This is to certify that this Professional Training Report is the bonafide work of SARANYA D (Reg. No.39310004) who underwent the professional training in **"Sensing the soil quality using IoT"** under our supervision from December 2020 to March 2021.

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DECLARATION

I, SARANYA D (Reg. No. 39310004) hereby declare that the Professional Training Report on “**Sensing the soil quality using IoT**” done by me under the guidance of Dr.R.SUBHASHINI, ME., Ph.D., at Sathyabama Institute of Science and Technology is submitted in partial fulfillment of the requirements for the award of Master’s of Engineering degree in **Computer science and Engineering**.

DATE:

PLACE:

SIGNATURE OF THE CANDIDATES

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I am pleased to acknowledge our sincere thanks to the Board of **Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

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I would like to express our sincere and deep sense of gratitude to our Project Guide **Dr.R.Subhashini M.E., Ph.D. ,** for his valuable guidance, suggestions and constant encouragement paved the way for the successful completion of our project work.

I wish to express our thanks to all Teaching and Non-teaching staff members of the **Department of Computer Science and Engineering** who were helpful in many ways for the completion of the project.

ABSTRACT

Agriculture plays the major role in economics and survival of people in India. The main objective of the project is to implement the irrigation system in a smart way. In this project, a sensing the soil quality is proposed in which the farmer will be able to monitor soil moisture, soil temperature, and soil supplement content like Nitrogen, Phosphorous and Potassium. The sensor placed in the soil which helps to find the level of nutrients. Soil is the base of agriculture. Soil provides nutrients that increase the growth of a crop. These properties can be sensed by the open-source hardware, and they can be used in the field. The Farmer can screen every one of these boundaries remotely on a cell phone or the PC system. To quantify the Soil moisture, we will utilize a capacitive soil moisture sensor. The temperature of the moisture A can be estimated utilizing the DS18B20 Waterproof Temperature Sensor. Additionally, to gauge the soil NPK Values, we will utilize a soil NPK sensor. All these sensors can be easily interfaced with arduino.

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LIST OF ABBREVIATIONS

IoT	Internet of Things
NPK sensor	Nitrogen, Phosphorus, and Potassium
WiFi	Wireless Fidelity
GSM	Global System for Mobile Communication
API Key	Application Programming interface key
SSID	Service Set Identifier

CHAPTER 1

1. INTRODUCTION

The Agriculture is the major source of income for the largest population in India and is major contributor to Indian economy. However, technological involvement and its usability have to be grown still and cultivated for agro sector in India. Although few initiatives have also been taken by the Indian Government for providing online and mobile messaging services to farmers related to agricultural queries and agro vendor's information to farmers. Based on the survey it is observed that agriculture contributes 27% to GDP, and Provides employment to 70% of Indian population.

IoT is changing the agriculture domain and empowering farmers to fight with the huge difficulties they face. The agriculture must overcome expanding water deficiencies, restricted availability of lands, while meeting the expanding consumption needs of a world population. New innovative IoT applications are addressing these issues and increasing the quality, quality, sustainability and cost effectiveness of agriculture production.

Agriculture is the backbone of Indian Economy. In today's world, as we see rapid growth in global population, agriculture becomes more important to meet the needs of the human race. However, agriculture requires irrigation and with every year we have more water consumption than rainfall, it becomes critical for growers to find ways to conserve water while still achieving the highest yield. But in the present era, the farmers have been using irrigation technique through the manual control in which they irrigate the land at the regular interval.

The IoT based soil supplement checking and Investigation frameworks utilizing Arduino and ESP32, Soil is the base of agribusiness. Soil gives supplements that expansion the development of a yield. Some compound and actual properties of soil, like its dampness, temperature, soil nitrogen, phosphorous and potassium content vigorously influence the yield of a harvest. These properties can be detected by the open-source equipment, and they can be utilized in the field.

Soil Monitoring with IoT uses technology to empower farmers and producers to maximise yield, reduce disease and optimise resources. IoT sensors can measure soil temperature, NPK, volumetric water content, Photosynthetic radiation, soil water potential and soil oxygen levels. Data from the IoT sensors are then transmitted back to a central point(or the cloud) for analysis, visualisation and trend analysis.

The resultant data can be used to optimise farming operations, identify trends and make subtle adjustments to conditions to maximise crop yields and quality. The use of IoT in agriculture is known as Smart Agriculture or Smart Farming, and IoT is a central component of Precision Farming.

In this project, a soil Nutrient monitoring & analysis system is proposed in which the farmer will be able to monitor soil moisture, soil temperature, and soil nutrient content like Nitrogen, Phosphorous & Potassium. The farmer can monitor all these parameters wirelessly on a mobile phone or the PC System.

To measure the Soil Moisture, we will use a Capacitive Soil Moisture Sensor. The temperature of the soil can be measured using the DS18B20 Waterproof Temperature Sensor. Similarly, in order to measure the Soil NPK Values, we will use a Soil NPK Sensor. All these sensors can be easily interfaced with Arduino.

We will use the Thing speak Server to Monitor the data in graphical & numerical format. We need the GSM or WiFi network in the field to send the data to the server. But the agricultural field doesn't have access to these networks. In order to solve this, we will use the NRF2401 Wireless transceiver Module to send the data from sensor Node to Gateway. The data from the transmitter can be transmitted wirelessly from a kilometer distance to the Receiver. The receiver is built using ESP32 WiFi Module, which has access to WiFi Network. Using this WiFi Network, the data can be uploaded to Thing speak Server.

CHAPTER 2

LITERATURE SURVEY

TITLE: Soil Nutrients Prediction using Remote Sensing Data in Western India: An Evaluation of Machine Learning Models.

AUTHOR: Gunkirat Kaur, Kamal Das, Jagabondhu Hazra.

YEAR: 2020

DESCRIPTION:

Soil nutrient estimation can be used as a key input to increase crop yield and agriculture fertilization. Due to the shortage of the ground measured spectrum technology and costliness to obtain hyperspectral images, multispectral remote sensing data is used to explore the soil nutrient content estimation. In this paper, we have used optical remote sensing data (Landsat-8 and Sentinel-2), terrain/climate data (precipitation, radiation, slope etc.) and ground truth value to estimate four nutrients: N, K, P, and OC for two districts of Maharashtra, India. We compared four linear and non-linear regression models: multiple linear regression (MLR), random forest regression (RFR), support vector machine for regression (SVR) and gradient boosting (GB) for estimation of NPK and OC. Comparative results suggest that, GB and RFR performed better than other models with sMAPE in range of 0.125-0.377 for all nutrients, which is better or comparable with literature reported accuracy [1]. Therefore, the approach has potential to generate high resolution (< 1 ha) soil nutrients map and can reduce soil sampling effort/cost.

TITLE: Automated Irrigation System Using IoT.

AUTHOR: M Sandhiya, R Abirami, V Jaiganesh.

YEAR: 2020

DESCRIPTION:

Agriculture is the basic spring of food supply for all nations in the world. The system consists of a sensor network for humidity, temperature, soil moisture, and rain sensors. Soil moisture, temperature, rain sensor, are placed in the origin zone of the crops. The microcontroller of the controller unit is set threshold values of the temperature and moisture content. The controller unit is used to collect all the details. In addition to that soil moisture sensor placed in this field, if it is excess water the buzzer gets automatically the turn on. Real-time monitoring data can be shown on the LCD. This paper is mainly focused on improving the agricultural fields yield by providing a monitoring system with effective and efficient usage of water resources. Thus further development in this project will lead to greater efficiency in the field of agriculture.

TITLE: An IOT Based Smart Irrigation System Using Soil Moisture and Weather Prediction

AUTHOR: Dr. S. Velmurugan

YEAR: May 2,2020

DESCRIPTION:

The scarcity of clean water resources around the globe has generated a need for their optimum utilization. Internet of Things (IoT) solutions, based on the application specific sensors' data acquisition and intelligent processing, are bridging the gaps between the cyber and physical worlds. IoT based smart irrigation systems can help in achieving optimum water-resource utilization in the precision farming landscape. This paper presents an open-source technology based smart system to predict the irrigation requirements of a field using the sensing of ground parameter like soil moisture, soil temperature, and environmental conditions along with the weather forecast data from the Internet. The intelligence of the proposed system is based on a smart algorithm, which considers sensed data along with the weather forecast parameters like precipitation, air temperature, humidity, and UV for the near future. The complete system has been developed and deployed on a pilot scale, where the sensor node data is wirelessly collected over the cloud using web-services and a web-based information visualization and decision support system provides the real-time information insights based on the analysis of sensors data and weather forecast data. The paper describes the system and discusses in detail the information processing results of three weeks data based on the proposed algorithm. The system is fully functional and the prediction results are very encouraging.

TITLE: Sensing Methodologies in Agriculture for Soil Moisture
And Nutrient Monitoring.

AUTHOR: Bhuwan Kashyap, Ratnesh Kumar.

YEAR: 2020

DESCRIPTION:

Development and deployment of sensing technologies is one of the main steps in achieving sustainability in crop production through precision agriculture. Key sensing methodologies developed for monitoring soil moisture and nutrients with recent advances in the sensing devices reported in literature using those techniques are overviewed in this article. The soil moisture determination has been divided into four main sections describing soil moisture measurement metrics and laboratory-based testing, followed by in-situ, remote and proximal sensing techniques. The application, advantages and limitations for each of the mentioned technologies are discussed. The nutrient monitoring methods are reviewed beginning with laboratory-based methods, ion-selective membrane based sensors, bio-sensors, spectroscopy-based methods, and capillary electrophoresis-based systems for inorganic ion detection. Attention has been given to the core principle of detection while reporting recent sensors developed using the mentioned concepts. The latest works reported on the different sensing methodologies point towards the trend of developing low-cost, easy to use, field-deployable or portable sensing systems aimed towards improving technology adoption in crop production leading to efficient site-specific soil and crop management which in turn will bring us closer to reaching sustainability in the practice of agriculture.

CHAPTER 3

SENSORS USED: SOIL MOISTURE, TEMPERATURE & NPK

The project IOT based soil Nutrient Monitoring; Analysis & Testing requires some sensors which are explained in detail below.

3.1 Capacitive Soil Moisture Sensor

To measure the Soil Moisture Level we need a Soil Moisture Sensor. For this application, a capacitive type of Soil Moisture Sensor is preferred. We will use an analog capacitive soil moisture sensor that measures soil moisture levels by capacitive sensing. It means the capacitance is varied on the basis of water content present in the soil. The measured capacitance is converted into voltage level basically from 1.2V to 3.0V maximum. The advantage of Capacitive Soil Moisture Sensor is that they are made of a corrosion-resistant material giving it long service life.



Capacitive Soil Moisture Sensor

The Capacitive Soil Moisture Sensor v2.0 operates between 3.3V-5.5V DC voltage. The output is in Analogy form up to 3V Maximum. We can convert the output voltage into the Percentage value.

3.2 DS18B20 Waterproof Temperature Sensor

This is a pre-wired and waterproofed version of the DS18B20 Sensor used to measure something far away, or in wet conditions. The Sensor can measure the temperature between -55 to 125°C (-67°F to +257°F). The cable is jacketed in PVC. These 1-wire digital temperature sensors are fairly precise, i.e $\pm 0.5^{\circ}\text{C}$ over much of the range. They work great with any microcontroller using a single digital pin.



DS18B20 Waterproof Temperature Sensor

The sensor requires two libraries like Dallas Temperature Sensor Library & One-Wire Library. It also requires a 4.7k resistor, which is required as a pull up from the DATA to the VCC line when using the sensor.

Specifications

- Programmable Digital Temperature Sensor
- Communicates using 1-Wire method
- Operating voltage: 3V to 5V
- Temperature Range: -55°C to +125°C
- Output Resolution: 9-bit to 12-bit (programmable)
- Unique 64-bit address enables multiplexing
- Conversion time: 750ms at 12-bit

3.3 NPK Sensor

The soil NPK sensor is suitable for detecting the content of nitrogen, phosphorus, and potassium in the soil. It helps in determining the fertility of the soil. The sensor can be buried in the soil for a long time.



NPK Sensor

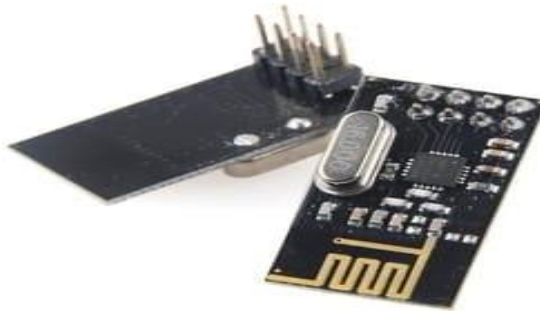
The sensor doesn't require any chemical reagent. The sensor has high measurement accuracy, fast response speed, and good interchangeability & can be used with any microcontroller. You cannot use the sensor directly with the microcontroller as it has a Modbus Communication port. Hence you need any Modbus Module like RS485/MAX485 and connect the sensor to the microcontroller.

The sensor operates on 9-24V & power consumption is very low. The accuracy of the sensor is up to within 2%. The nitrogen, phosphorous & potassium measuring resolution is up to 1mg/kg (mg/l).

Specifications

- Power: 9V-24V
- Measuring Range: 0-1999 mg/kg(mg/l)
- Operating Temperature: 5-45 °C
- Resolution: 1mg/kg
- Precision: $\pm 2\%$ F.S
- Output signal: RS485

3.4 NRF24L01 Wireless Transceiver Module



NRF24L01 Wireless Transceiver

The nRF24L01 is a wireless transceiver module, i.e. each module can both send & receive data. It works within the frequency of 2.4GHz. The modules when operated efficiently can cover a distance of 100 meters.



Duck-antenna & special RFX2401C

The second version of this module, i.e. nRF24L01 PA+LNA comes with an SMA connector, duck-antenna & special RFX2401C chip which integrates the PA + LNA. This range extender chip along with a duck-antenna helps the module achieve a significantly larger transmission range about 1000m.

The module operates at 3.3V but its SPI pins are 5V tolerable. The NRF24L01 module works with the help of SPI communications hence you can use NRF24L01 with any microcontroller with SPI Pins like ESP32 WiFi Module or Arduino Boards.

3.5 Circuit

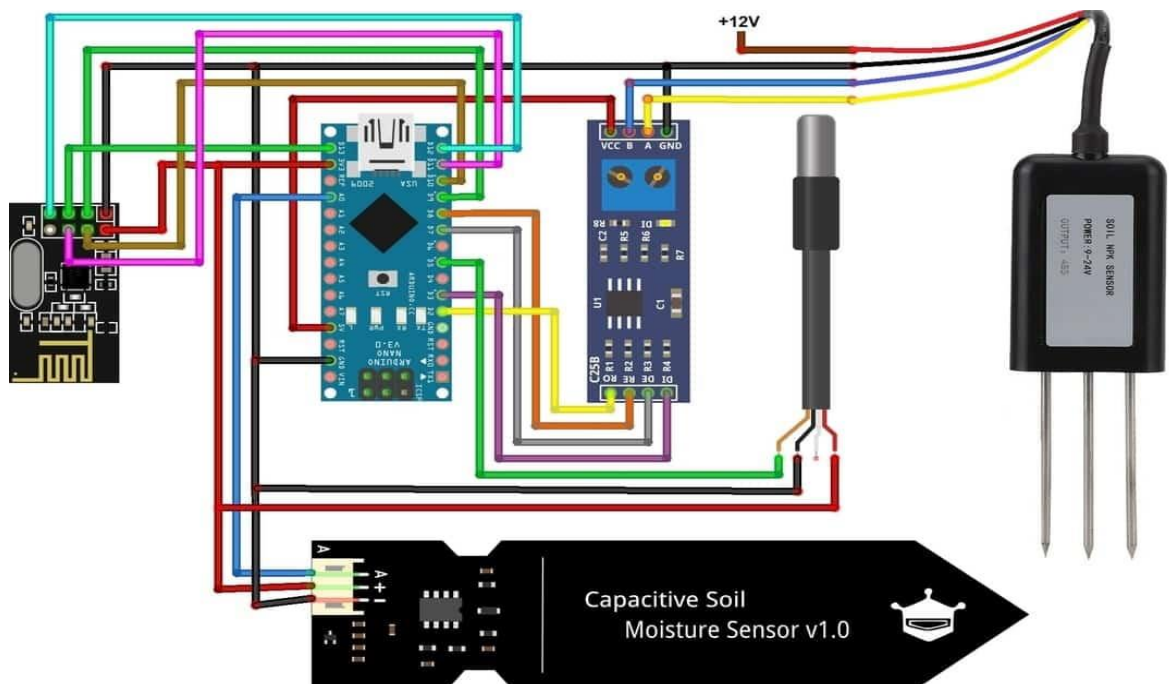
3.5.1 IoT Based Soil Nutrient Monitoring using IoT

IoT Based Soil Nutrient Monitoring with Arduino & ESP32. We have to make a pair of circuits for that. The one circuit is called a Sensor Node that is made using the Arduino Nano Board & some sensors along with the NRF24L01 Transceiver Module.

For the gateway part, we used ESP32 WiFi Module along with the NRF24L01 Transceiver Module. The Sensor Node Sends the data to the Gateway & the Gateway uploads the data to the Thing speak Server.

3.5.2 Sensor Node Circuit

The sensor Node Circuit & connection diagram is given below. The Sensor Node comprises of Arduino Nano Board, NRF24L01 Transceiver Module, Soil Moisture Sensor, DS18B20 Temperature Sensor & Soil NPK Sensor.

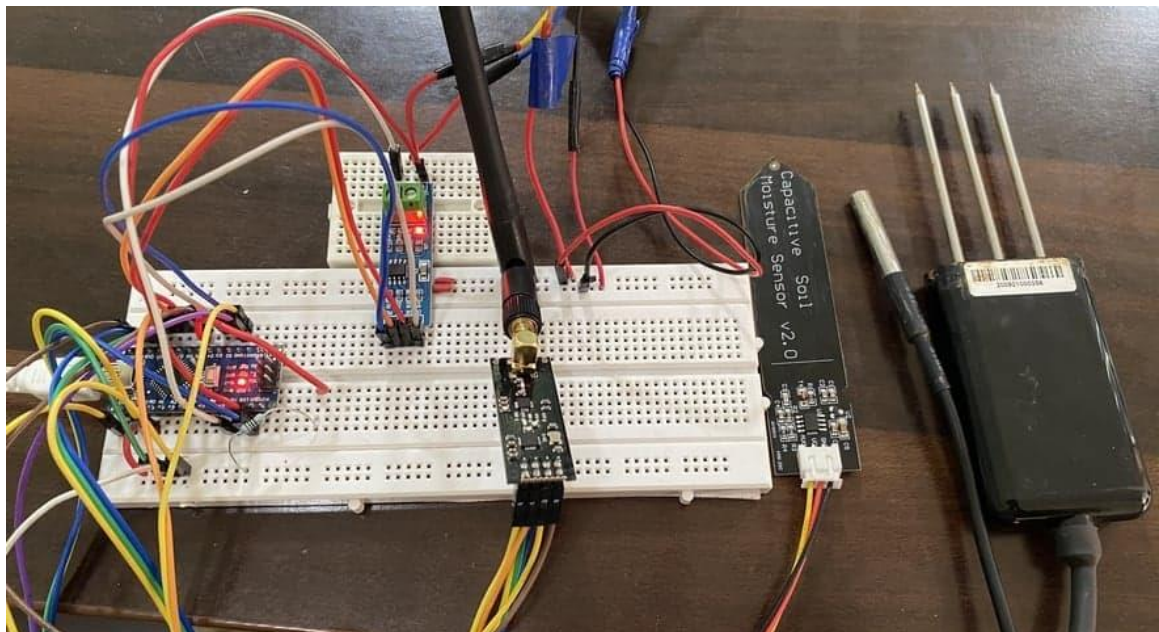


Sensor Node Circuit

The connection between NRF24L01 & Arduino Nano Board is given below.

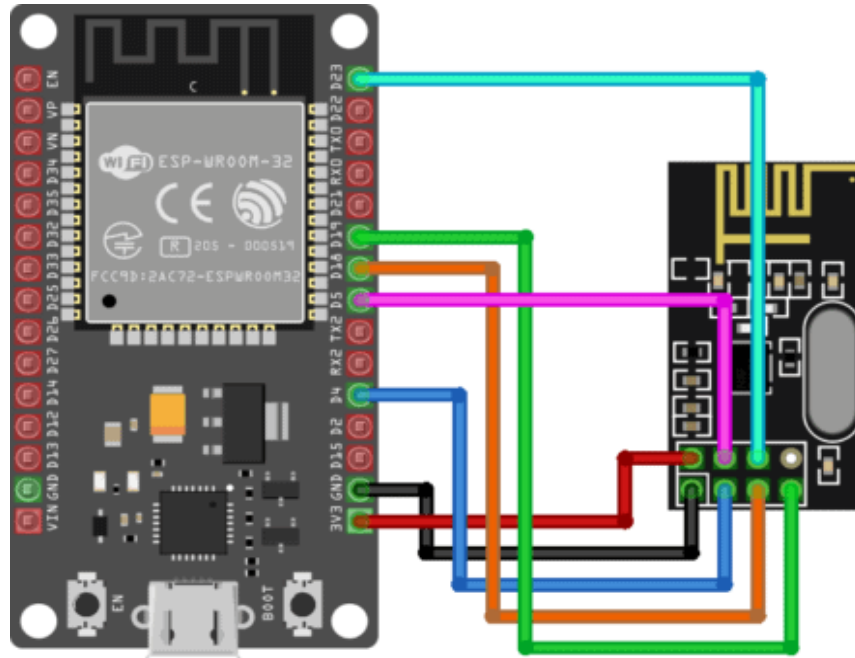
NRF24L01 VCC	3.3V of Arduino
NRF24L01 CSN	10 of Arduino
NRF24L01 MOSI	11 of Arduino
NRF24L01 GND	GND of Arduino
NRF24L01 CE	9 of Arduino
NRF24L01 SCK	13 of Arduino
NRF24L01 MISO	12 of Arduino

Apart from the NRF24L01 Arduino Connections, the Sensor are connected to analog & digital pin of Arduino. The Capacitive Soil Moisture Sensor Analog pin is connected to A0 of Arduino. Similarly, the DS18B20 sensor is connected to the D5 of Arduino. And the NPK Sensor is connected to Arduino via Modbus Pin to 2,3,7,8 Pin of Arduino. The NPK Sensor works between 9V-24V. So an extra supply is required for the circuit. The rest of all components can be powered via Arduino 5V/3.3V Pin.



3.5.3 GATEWAY CIRCUIT

The IoT based Soil Nutrient Analysis & Monitoring also involves the Gateway. The Gateway is designed using ESP32 WiFi Module & NRF24L01 Wireless Transceiver Module.



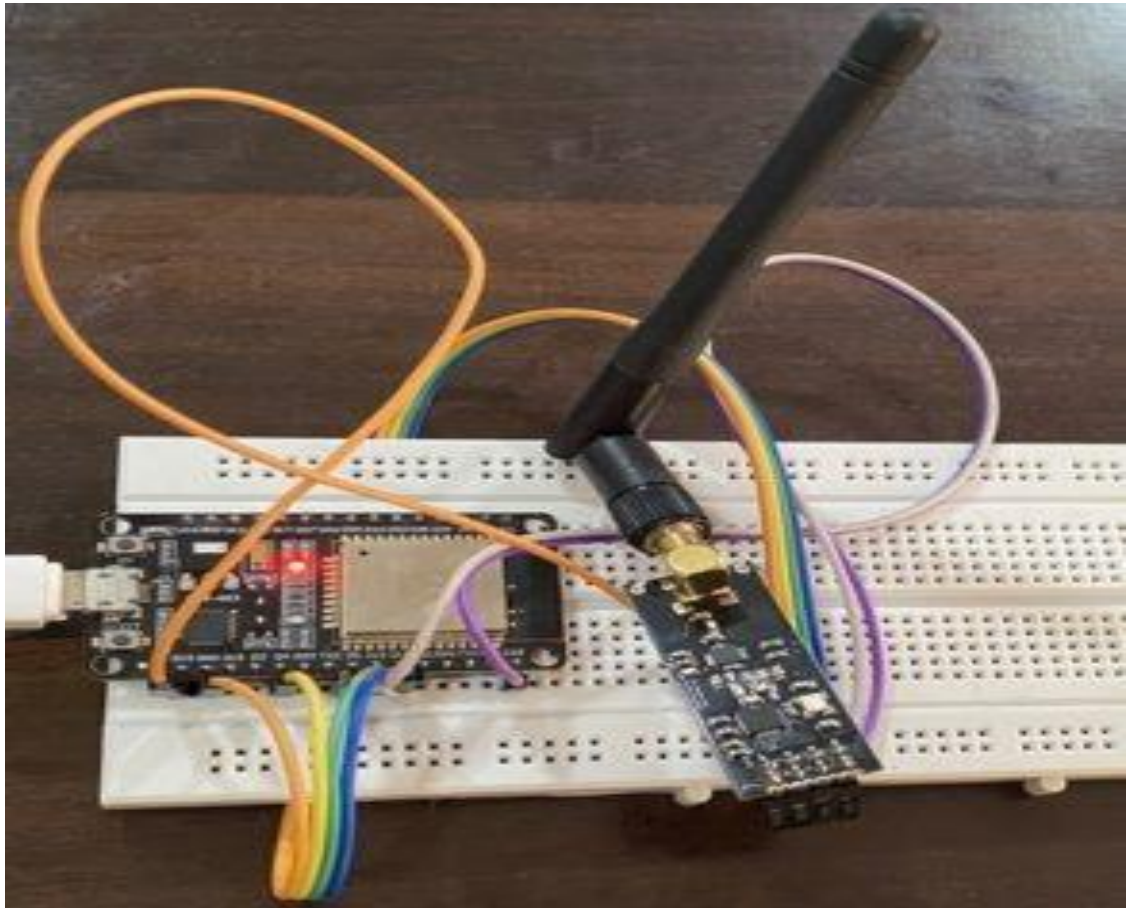
GATEWAY CIRCUIT

The sensor node comprises of NRF24L01 interfaced with any Microcontroller Board like Arduino or Node MCU ESP8266. In my case, I am using Node MCU Board as a sensor Node Circuit, The sensor Node contains a sensor whose data is to be transmitted to the Gateway using the NRF24L01 transceiver module. Here for a simple demonstration, I am using DHT11 Humidity & Temperature Sensor. Thus we will be sending the Humidity & Temperature Data to Gateway.

On the receiver end, we will be Interfacing Node MCU ESP8266-12E Board with the NRF24L01 transceiver Module. This is the Receiver or also called as Gateway. The Gateway has the ability to get connected to the WIFI network. The Gateway Receives Temperature & Humidity Data wirelessly via the NRF34L01 transceiver module. The Gateway will now upload the Temperature & Humidity Value to Thingspeak Server

The connection between ESP32 Board & NRF24L01 Wireless Transceiver Module is given below.

<i>NRF24L01</i> VCC	3.3V of	<i>ESP32</i>
<i>NRF24L01</i> CSN	D5 of	<i>ESP32</i>
<i>NRF24L01</i> MOSI	D23 of	<i>ESP32</i>
<i>NRF24L01</i> GND	GND of	<i>ESP32</i>
<i>NRF24L01</i> CE	D4 of	<i>ESP32</i>
<i>NRF24L01</i> SCK	D18 of	<i>ESP32</i>
<i>NRF24L01</i> MISO	D19 of	<i>ESP32</i>



CHAPTER 4

METHODOLOGY

4.1 SYSTEM REQUIREMENTS:

4.1.1 Software Requirements:

Software requirements deals with defining resources requirements and prerequisites that needs to be installed on a computer to provide functioning of an application the minimal software requirements are as follows,

Software Used : Arduino IDE
Thingspeak Server

4.1.2 Hardware Requirements:

The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware. The minimal hardware requirements are as follows,

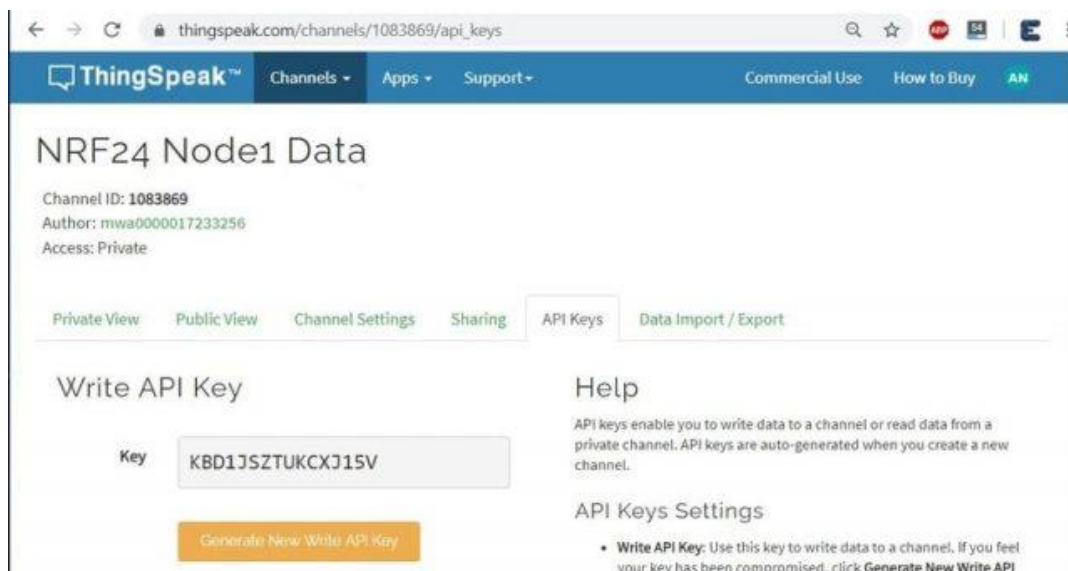
Sensor : Temperature sensor, NKP, moisture sensor
Board : Gateway circuit, Node MCU
Setting Up: Thingspeak Server

4.2 Setting Up Thingspeak Server

the Thingspeak Account. To set up Thingspeak follow the following Steps:
In The IoT Based IoT Soil Nutrient Monitoring & Analysis is done on Thingspeak Server. So, we need to setup

Step 1: Visit <https://thingspeak.com/> and create your account by filling up the details.

Step 2: Create a New Channel by Clicking on “Channel” & fill up the following details as shown in the image below.



ThingSpeak™

Soil Nutrient Monitoring

Channel ID: 983437
 Author: mwa0000117233256
 Access: Public

Private View Public View **Channel Settings** Sharing API Keys Data Import / Export

Channel Settings

Percentage complete: 30%

Channel ID: 983437

Name: Soil Nutrient Monitoring

Description:

Field 1: Nitrogen ☒

Field 2: Phosphorus ☒

Field 3: Potassium ☒

Field 4: Soil Temp ☒

Field 5: Soil Moisture ☒

Help

Channels store all the data that a ThingSpeak application collects. Each channel includes eight fields that can hold any type of data, plus three fields for location data and one for status data. Once you collect data in a channel, you can use ThingSpeak apps to analyze and visualize it.

Channel Settings

- **Percentage complete:** Calculated based on data entered into the various fields of a channel. Enter the name, description, location, URI, video, and tags to complete your channel.
- **Channel Name:** Enter a unique name for the ThingSpeak channel.
- **Description:** Enter a description of the ThingSpeak channel.
- **Fields:** Check the box to enable the field, and enter a field name. Each ThingSpeak channel can have up to 8 fields.
- **Metadata:** Enter information about channel data, including JSON, XML, or CSV data.

Step 3: Click on API Key, you will see the “Write API Key“. Copy the API Key.

This is very important; it will be required in Code Part.

Step 4: You can click on the “Private View” & customize the display window as you want.

4.3 Adding Necessary Library To Arduino IDE

4.3.1 NRF24L01 Library

This library is designed to be maximally compliant with the intended operation of the nRF24L01 2.4GHz Wireless Transceiver Module. This chip uses the SPI bus, plus two-chip control pins.

4.3.2 RH24 Library

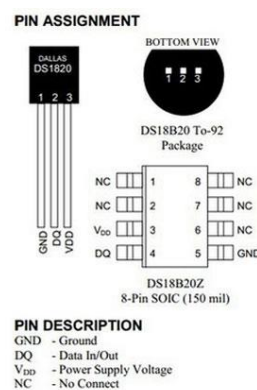
This is the Radio Head Packet Radio library for embedded microprocessors. It provides a complete object-oriented library for sending and receiving packetized messages via a variety of common data radios and other transports on a range of embedded microprocessors.

4.3.3 One Wire Library

The One Wire library lets you access 1-wire devices made by Maxim/Dallas, such as DS18B20 Temperature sensors. One Wire requires a single 4.7K pull-up resistor, connected between the pin. and your power supply.

4.3.4 Dallas Temperature Sensor Library

This is the Arduino Library for Maxim Temperature Integrated Circuits. This library supports DS18B20, DS1822, DS1820 & MAX31820. The Dallas 1-Wire protocol is somewhat complex and requires a bunch of code to parse out the communication. The Dallas Temperature Sensor Library can issue simple commands to get temperature readings from the sensor.



4.4 Source Code/Program

4.4.1 IoT Soil Nutrient Monitoring & Analysis

The Source Code/Program for IoT Soil Nutrient Monitoring, Analysis & Testing part has a pair a code. One is for the Transmitter/Node part where the code needs to be uploaded to the Arduino IDE. The other part is the Receiver/Gateway part where the code needs to be uploaded to the ESP32 Board

4.5 Sensor Node/Transmitter Code

```
#include <SPI.h>
#include <SoftwareSerial.h>
#include <onewire.h>
#include <DallasTemperature.h>
#include <nRF24L01.h>
#include <RF24.h>
RF24 radio(9,10);
Const uint64_t address = 0xF0F0F0F0E1LL;
#define ONE_WIRE_BUS 5
#define RE 8
#define DE 7
Const byte code[ ] = {0x01, 0x03, 0x00, 0x1e, 0x00, 0x03, 0x65, 0xCD};
byte values[11];
SoftwareSerial mod(2, 3);
Const int Airvalue = 645;
Const int Watervalue = 254;
int soilmoisturevalue = 0;
int soilmoisturepercent = 0;

float temperature;
int nitrogen;
int phosphorous;
int potassium;
```

```
onewire onewire(ONE_WIRE_BUS);
DallasTemperature sensors(&onewire);
```

Struct Myvariable

```
{
  Byte soilmoisturepercent;
  Byte nitrogen;
  Byte phosphorous;
  Byte potassium;
  Byte temperature;
};
Myvariable variable;
```

Void setup()

```
{
  Serial.begin(9600);
  Mod.begin(9600);
  Radio.begin();
  Radio.openWritingPipe(address);
  Radio.setPALevel(RF24_PA_MIN);
  Radio.stopListening();
  Sensors.begin();
  pinMode(RE, OUTPUT);
  pinMode(DE, OUTPUT);
}
```

Void loop()

```
{
  Byte Val;
  digitalWrite(DE, HIGH);
  digitalWrite(RE, HIGH);
  delay(10);
  if (mod.write(code, sizeof(code)) == 8)
  {
```

```

digitalWrite(DE, LOW);
digitalWrite(RE, LOW);
for (byte i = 0; i < 11; i++ )
{
    Values[i] = mod.read();
    Serial.print(values[i], HEX);
}
Serial.println();
}
Nitrogen = values[4];
Phosphorous = values[6];
Potassium = values[8];
Delay(1500);
soilMoisturevalue = analogRead(A0);
soilmoisturepercent = map(soilMoistureValue, AirValue, WaterValue, 0, 100);
{
    If (soilmoisturepercent >= 100)
    {
        Soilmoisturepercent = 100;
    }
    Else if (soilmoisturepercent <= 0)
    {
        Soilmoisturepercent = 0;
    }
    Else if (soilmoisturepercent > 0 && soilmoisturepercent <100)
    {
        Soilmoisturepercent = soilmoisturepercent;
    }
}
Delay(1500);

Sensors.requestTemperatures();
Temperature = sensors.getTempCByIndex(0);

```

```

Variable .soilmoisturepercent = soilmoisturepercent;
Variable .nitrogen = nitrogen;
Variable .phosphorous = phosphorous;
Variable .potassium = potassium;
Variable .temperature = temperature;
Delay(1500);

Serial.print("soil Moisture: ");
Serial.print(variable.soilmoisturepercent);
Serial.println("%");
Serial.print("Nitrogen: ");
Serial.print(variable.nitrogen);
Serial.println(" mg/kg");
Serial.print("Phosphorous; ");
Serial.print(variable.phosphorous);
Serial.println(" mg/kg");
Serial.print("potassium: ");
Serial.print(variable.potassium);
Serial.println(" mg/kg");
Serial.print("Temperature: ");
Serial.print(variable.temperature);
Serial.println("*C");
Serial.println();
Radio.write(&variable, sizeof(Myvariable));
Serial.println("Data Packet Sent");
Serial.println("");
Delay(10000);
}

```

4.6 Gateway/Receiver Code

The Code need to be uploaded to the ESP32 Board. But before uploading the code, you need to make changes to the WiFi SSID & Password from the following line.

```
const char* ssid = "*****",  
const char* password = "*****",
```

Also replace the Thingspeak API Key with your API Key.

```
String apikey = "*****",
```

After updating the WiFi SSID & Password, you can now finally upload the code to the ESP32 WiFi Module.

```
#include <WiFi.h>  
#include <SPI.h>  
#include <nRF24L01.h>  
#include <RF24.h>  
String apiKey = "FTY1Txxxxxx1NGU";  
Const char* ssid = "*****",  
Const char* password = "*****",  
Const char* server = "api.thingspeak.com";
```

```
RF24 radio(4, 5);  
Const uint64_t address = 0xF0F0F0F0E1LL;  
Struct MyVariable  
{  
  Byte soilmoisturepercent;  
  Byte nitrogen;  
  Byte phosphorous;  
  Byte potassium;  
  Byte temperature;  
};
```

```

MyVariable variable;
WiFiClient client;
Void setup()
{
  Serial.begin(115200);
  Radio.begin();
  Radio.openReadingPipe(0, address);
  Radio.setPALevel(RF24_PA_MIN);
  Radio.StartListening();
  Serial.println("receiver started....");
  Serial.print(connecting to ");
  Serial.println(ssid);
  Serial.println();
  WiFi.begin(ssid, password);
  While (WiFi.status() != WL_CONNECTED)
  {
    Delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial,println("WiFi connected");
}
Int recvData()
{
  If ( radio.available() )
  {
    Radio.read(&variable, sizeof(Myvariable));
    Return 1;
  }
  Return 0;
}
Void loop()
{
  If(recvData())

```

```

{
    Serial.println("Data Received:");
    Serial.print("Soil Moisture: ");
    Serial.print(variable.soilmoisturepercent);
    Serial.println("%");

    Serial.print("Nitrogen: ");
    Serial.print(variable.nitrogen);
    Serial.println("mg/kg");
    Serial.print("phosphorous: ");
    Serial.print(variable.phosphorous);
    Serial.println(" mg/kg");
    Serial.print("Potassium: ");
    Serial.print(variable.potassium);
    Serial.println(" mg/kg");

    Serial.print("Temperature: ");
    Serial.print(variable.temperature);
    Serial.println("*C");
    Serial.println();
    If (client.connect(server, 80))
    {

        String postStr = apiKey;
        postStr += "&field1=";
        postStr += string(variable.soilmoisturepercent);
        postStr += "&field2=";
        postStr += string(variable.nitrogen);
        postStr += "&field3=";
        postStr += string(variable.phosphorous);
        postStr += "&field4=";
        postStr += string(variable.potassium);
        postStr += "&field5=";
        postStr += string(variable.temperature);
    }
}

```

```

postStr += "\r\n\r\n\r\n\r\n\r\n\r\n";

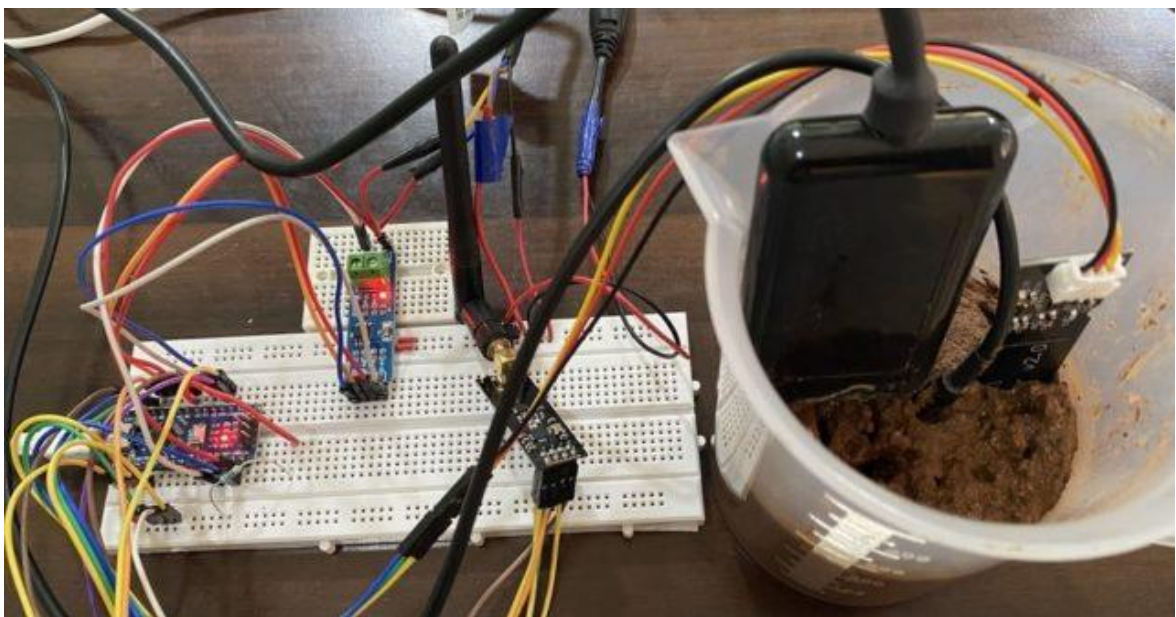
client.print("POST /update HTTP/1.1\n");
client.print("HOST: api.thingspeak.com\n");
client.print("connection: close\n");
client.print("X-THINGSPEAKAPIKEY: " + apikey + "\n");
client.print("content-Type: application/x-www-form-urlencoded\n");
client.print("content-Length: ");
client.print(postStr.length());
client.print("\n\n");
client.print(postStr);
delay(1000);
serial.println("Data Sent to Server");
}
    Client.stop();
}
}

```

CHAPTER 5

RESULT

After successfully uploading the code to the Arduino & ESP32 Board, you can start testing the device. So for that place all the sensor into the soil as shown in image below.



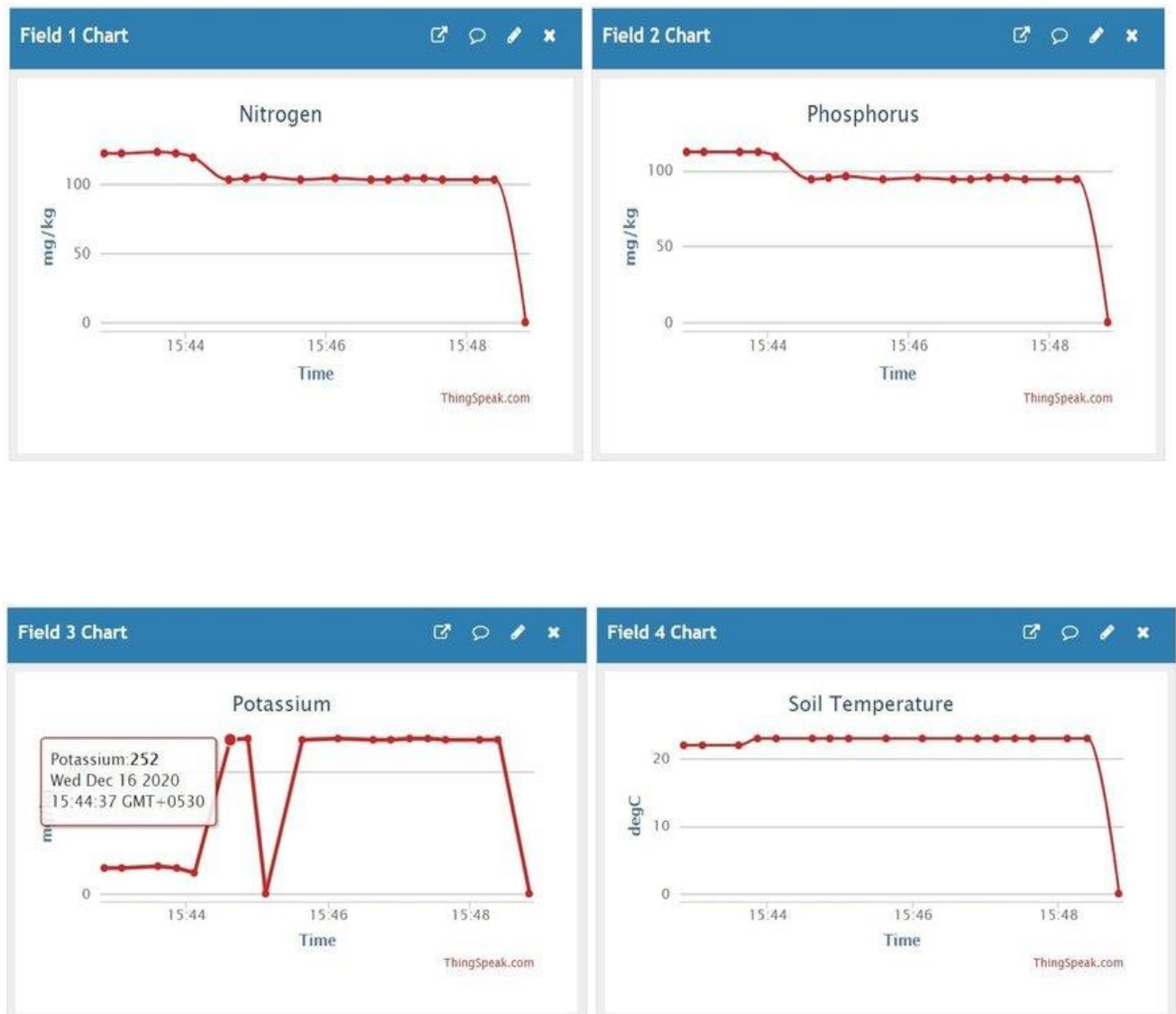
Now open both the serial Monitor to check whether the data transmission is happening or not. The Serial Monitor on the sensor node shows the data read from the sensor like the value of soil moisture in percentage, the temperature in degree Celsius, the NPK Content in mg/kg.

The data is transmitted wirelessly to the receiver/gateway section. The gateway collects the data and uploads it to the Thingspeak Server. You can just visit the private view of the Thingspeak Dashboard. You will see the data being logged into the Thingspeak Server.

So, this is how you can make a simple **Sensing the Soil Nutrient** using IoT, Arduino & some Soil Sensors .

SCREENSHOTS

DATA VISUALIZATION



CHAPTER 6

CONCLUSION AND FUTURE WORK

This paper illustrates to get the right decision for farmers, Especially agriculture can be done in smart way. Along these lines, the farmer's tries to bring efficiency and precision in the field of agribusiness through computerizing the whole procedure with the assistance of the Internet of Things. It additionally attempts to remain away from the overexploitation of essential resources which may get cleaned out not long from now.

This goes probably as a complete group that every one of the farmer would need to have. This assignment is completely arranged towards farmer government assistance and cultivating improvement. It assists the farmers with the complete method of developing from the starting till end. With taking incredible thought of these harvests, it urges the farmers to leave their poverty by giving a respectable proportion of yield at the end. It as well ensures the prosperity and sustenance of the yields. There is no uncertainty that this undertaking would be a market hit.

The proposed algorithm uses sensors' data of recent past and the weather forecasted data for predicted of soil moisture for upcoming days. The predicted value of the soil moisture is better in terms of their accuracy and error rate. Further, the prediction approach is integrated into a standalone system prototype. The system prototype is cost effective, as it is based on the open standard technologies. The auto mode makes it a smart system and it can be further customized for application specific scenarios. In future, we are planning to conduct a water saving analysis based on proposed algorithm with multiple nodes along with minimizing the system cost.

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